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Preliminary Weight Yield Tables for Evenaged Upland Oak Forests

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PREFACE

The yield tables reported in this publication are preliminary in nature. They are based on stand tables for fully stocked, evenaged, second-growth upland oak forests published by Schnur (1937) and weight equations developed by Wiant *et al.* (1977). Comparisons of the weight equations developed for northern West Virginia with those for the same species in the southern part of the state and even outside the state indicate that these yield tables should prove useful in many evenaged, eastern upland oak forests.

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Preliminary Weight Yield Tables for Evenaged Upland Oak Forests

by

Harry V. Wiant, Jr.

and

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The utility of weight as a unit of measure in forestry has long been recognized, and interest has been stimulated by the introduction of whole-tree chipping operations. Weight tables were recently developed for some Appalachian hardwoods in northern West Virginia (Wiant *et al.*, 1977), and they compared well with results obtained in weight studies in the southern part of the state and in Maine (Castaneda, 1977). The weight tables are single-entry using dbh only, making it possible to use Schnur's (1937) stand tables for the upland oak region to develop weight yield tables.

Procedure

Schnur's stand tables give the number of trees by diameter classes for 10-year intervals between 10 and 100 years and for 10-foot site index classes between site indexes 40 and 80. The number of trees in each cell is given as white oaks (WO), black oaks (BO), other intolerant (OI), and other tolerant (OT). Weight equations developed by Wiant *et al.* (1977) times the number of trees provided yields for each cell. The equations for the white oak group were used for white oaks and for the red oak group for black oaks. Schnur found oaks comprised 83 percent of the basal area in stands he sampled. An examination of the species classed as "other tolerant species" led us to use the equations for red maple. The "other intolerant class" included many species, and an average of hickory and yellow-poplar equations was selected as most appropriate. All stem material less than 4 inches, diameter outside bark (dob), and limbs were considered as branches. Stumps, approximately ½-foot, roots, and leaves were excluded.

Results and Discussion

Per-acre weight yields for all diameters from 0.25-inch dbh and up are given in tables 1 to 4. Yields for trees 5-inches dbh and greater are given in tables 5 to 16. Equations used are included.

A number of interesting comparisons are feasible; a few of the more obvious are made here. For example, Table 17 shows the percent of total dry weight per acre which is bark. It can be seen that the percent bark decreases with increasing age and site index.

Table 18 indicates the percent of total yield of dry weight of wood which is in material less than 4-inches dob, and Table 19 makes a similar comparison for the green weight of wood and bark. These tables indicate the percentage increase in yield which is obtained by whole-tree chipping of all trees as compared to a conventional pulpwood harvest.

Table 21 demonstrates that short rotations would yield the maximum wood in terms of weight alone. The maximum yield per year is obtained at age 40 on the poorest site and 20 on the best. Economic problems, such as the cost of harvesting small trees (see Table 20), and ecological problems, such as nutrient depletion, will undoubtedly dictate longer rotations.

TABLE 1
Yield per acre of green weight (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	25243	26603	33759	36672	39739
20	47766	63564	69272	82731	107939
30	78012	101474	119311	142853	155318
40	104090	126523	149385	171885	191243
50	123118	148315	185366	210510	244530
60	144448	170806	210195	240910	262894
70	154209	187900	225071	252690	276616
80	169663	215394	240087	274761	287967
90	190402	229902	259013	289493	299825
100	205148	244424	269445	300799	317994

Class	Equation*
WO	$W = 2.68231D^{2.64500}$
BO	$W = 3.64938D^{2.54036}$
OI	$W = \frac{(4.09609D^{2.39108}) + (2.96160D^{2.62410})}{2}$
OT	$W = 3.78003D^{2.50438}$

*In all equations, "W" is weight in pounds, "D" is diameter outside bark at 4.5 feet (dbh).

TABLE 2
Yield per acre of dry weight (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	14572	15291	19414	21051	22808
20	27777	36860	40111	47787	62262
30	45459	58966	69092	82496	89481
40	60633	73417	86380	99125	110063
50	71630	85924	107011	121246	140522
60	83905	98829	121244	138570	150953
70	89455	108563	129683	145242	158759
80	98283	124304	138181	157877	165330
90	110213	132616	148982	166234	171976
100	118649	140902	154938	172748	182421

Class	Equation
WO	$W = 1.68565D^{2.60982}$
BO	$W = 2.09014D^{2.54052}$
OI	$W = \frac{(1.57792D^{2.51532}) + (1.93378D^{2.62090})}{2}$
OT	$W = 1.81301D^{2.56226}$

TABLE 3

Yield per acre of dry weight without bark (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	11960	12549	16009	17393	18833
20	23169	30865	33555	40048	52378
30	38407	49933	58478	69886	75859
40	51524	62509	73554	84464	93995
50	61131	73431	91342	103879	120547
60	71883	84565	104141	118992	129888
70	76664	93186	111665	125177	136937
80	84348	106960	119155	136558	143149
90	94810	114575	128605	143792	148780
100	102422	121904	133896	149772	158230

Class	Equation
WO	$W = 1.37211D^{2.63256}$
BO	$W = 1.63495D^{2.57352}$
OI	$W = \frac{(1.32004D^{2.51950}) + (1.54470D^{2.66452})}{2}$
OT	$W = 1.57279D^{2.56866}$

TABLE 4

Yield per acre of dry weight of bark (lbs.).

Total age (years)	Site Index				
	40	50	60	70	80
10	2612	2742	3405	3658	3975
20	4608	5995	6556	7739	9884
30	7052	9033	10614	12610	13622
40	9109	10908	12826	14661	16068
50	10499	12493	15669	17367	19975
60	12022	14264	17103	19578	21065
70	12791	15377	18018	20065	21822
80	13935	17344	19026	21319	22181
90	15403	18041	20377	22442	23196
100	16227	18998	21042	22976	24191

Note: (Table 2 values) - (Table 3 values).

TABLE 5

Yield per acre of green weight of trees 5-inches dbh or more (lbs.).

Total age (years)	Site Index				
	40	50	60	70	80
10	0	0	0	0	0
20	0	5643	11285	26132	58459
30	22905	51654	81053	117454	139468
40	63324	97817	131344	161486	185308
50	93593	129495	175095	204637	241355
60	124125	159254	203826	237351	261010
70	139747	179894	220655	250641	275411
80	158622	209500	236925	273265	287060
90	181617	225122	256688	288309	299099
100	198021	240766	267391	299892	317427

TABLE 6

Yield per acre of dry weight of trees 5-inches dbh or more (lbs.).

	Site Index				
Total age (years)	40	50	60	70	80
10	0	0	0	0	0
20	0	3275	6519	15086	33725
30	13319	29980	46928	67853	80425
40	36881	56760	76014	93229	106755
50	54455	75082	101200	117980	138784
60	72159	92252	117694	136612	149919
70	81153	104062	127240	144115	158100
80	92005	121024	136436	157052	164836
90	105260	129955	147701	165585	171575
100	114656	138882	153800	172254	182112

TABLE 7

Yield per acre of dry weight without bark of trees 5-inches dbh or more (lbs.).

	Site Index				
Total age (years)	40	50	60	70	80
10	0	0	0	0	0
20	0	2782	5524	12762	28560
30	11385	25572	39827	57515	68163
40	31474	48417	64735	79409	91138
50	46577	64195	86340	101052	119032
60	61875	78917	101067	117290	128987
70	69561	89306	109544	124197	136360
80	78952	104117	117636	135840	142719
90	90539	112271	127491	143224	148432
100	98969	120150	132908	149342	157961

TABLE 8

Yield per acre of dry weight of bark of trees 5-inches dbh or more (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	0	0	0	0	0
20	0	493	995	2324	5165
30	1934	4408	7101	10338	12262
40	5407	8343	11279	13820	15617
50	7878	10887	14860	16928	19752
60	10284	13335	16627	19322	20932
70	11592	14756	17696	19918	21740
80	13053	16907	18800	21212	22117
90	14721	17684	20210	22361	23143
100	15687	18732	20892	22912	24151

Note: (Table 6 values) - (Table 7 values)

TABLE 9

Yield per acre of green weight of branches of trees 5-inches dbh or more (lbs.).

	Site Index				
Total age (years)	40	50	60	70	80
10	0	0	0	0	0
20	0	2303	4492	9902	20028
30	8384	17191	26135	35185	39547
40	20206	29180	36578	41990	45544
50	27438	35484	44297	48791	55370
60	33779	40612	48085	54125	58167
70	36076	43121	50293	55754	60258
80	39287	48203	52986	59642	61975
90	43120	50842	56283	62267	64108
100	45747	53309	58145	64155	67179

Class	Equation
WO	$W = 184.52253 + 5.32224D^2 - 48.73647D$
BO	$W = 167.47727 + 5.57660D^2 - 42.43430D$
OI	$W = \frac{(352.07486 + 5.87535D^2 - 85.21641D) + (270.38361 + 7.87893D^2 - 77.76552D)}{2}$
OT	$W = 20.05467 + 2.00411D^2 + 4.66393D$

TABLE 10

Yield per acre of dry weight of branches of trees 5-inches dbh or more (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	0	0	0	0	0
20	0	1359	2644	5822	11744
30	4903	10031	15240	20459	22927
40	11734	16899	21119	24243	26383
50	15844	20460	25510	28186	32245
60	19424	23307	27689	31412	34057
70	20681	24739	29064	32499	35490
80	22459	27705	30678	34933	36627
90	24660	29276	32655	36553	38001
100	26169	30720	33864	37771	39954

Class	Equation
WO	$W = 124.89440 + 3.31160D^2 - 32.77917D$
BO	$W = 114.40758 + 3.55460D^2 - 29.31907D$
OI	$W = \frac{(146.29742 + 2.49589D^2 - 35.08911D) + (191.16897 + 5.36555D^2 - 54.98699D)}{2}$
OT	$W = 0.93846D^2 + 5.18726D - 0.55683$

TABLE 11

Yield per acre of dry weight of branches without bark of trees 5-inches dbh or more (lbs.).

Total age (years)	Site Index				
	40	50	60	70	80
10	0	0	0	0	0
20	0	1094	2131	4622	9448
30	3886	8070	12287	16494	18436
40	9448	13601	16957	19493	21186
50	12744	16419	20484	22529	25604
60	15572	18646	22108	24909	26867
70	16567	19737	23076	25565	27926
80	17874	21999	24088	27398	28838
90	19686	23079	25585	28594	29739
100	20714	24100	26508	29525	31330

Class	Equation
WO	$W = 93.46358 + 2.51626D^2 - 24.25798D$
BO	$W = 88.24854 + 2.83470D^2 - 22.75065D$
OI	$W = \dfrac{(132.85928 + 2.17263D^2 - 31.58192D) + (169.72489+4.78279D^2-49.67281D)}{2}$
OT	$W = 0.37005 + 0.74554D^2 + 4.69733D$

TABLE 12

Yield per acre of dry weight of branch bark of trees 5-inches dbh or more (lbs.).

	Site Index				
Total age (years)	40	50	60	70	80
10	0	0	0	0	0
20	0	265	513	1200	2296
30	1017	1961	2953	3965	4491
40	2286	3298	4162	4750	5197
50	3100	4041	5026	5657	6641
60	3852	4661	5581	6503	7190
70	4114	5002	5988	6934	7564
80	4585	5706	6590	7535	7789
90	4974	6197	7070	7959	8262
100	5455	6620	7356	8246	8624

Note: (Table 10 values) - (Table 11 values)

TABLE 13

Yield per acre of green weight to a 4-inch dob of trees 5-inches dbh or more (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	0	0	0	0	0
20	0	4315	8686	20597	46272
30	17558	40437	63946	92976	110174
40	49790	77575	104319	127592	145125
50	74371	103012	138835	160839	186566
60	99111	127060	161383	184632	199397
70	111926	143340	173427	193233	207565
80	127215	166213	185055	208705	215259
90	145725	178062	199540	218611	221585
100	158698	190034	206406	226344	233339

Class	Equation
WO	$W = 21.03646 + 14.57852D^2 - 48.52150D$
BO	$W = 208.76407 + 16.11594D^2 - 85.39248D$
OI	$W = \frac{(52.83929+14.27865D^2-57.70586D)+(0.45983D^{3.29484})}{2}$
OT	$W = 794.01142 + 25.61191D^2 - 246.17225D$

TABLE 14

Yield per acre of dry weight to a 4-inch dob of trees 5-inches dbh or more (lbs.).

	Site Index				
Total age (years)	40	50	60	70	80
10	0	0	0	0	0
20	0	2527	4978	11691	26089
30	10395	23382	36584	52898	62589
40	29026	44508	59540	72664	82628
50	42908	58985	79047	91381	106086
60	56950	72434	91624	104857	113485
70	64026	81438	98464	109874	118165
80	72456	94268	105017	118796	122717
90	82755	100988	113300	124627	126261
100	89947	107799	117224	129009	133163

Class	Equation
WO	$W = 1.50659D^{2.56224}$
BO	$W = 80.61690 + 8.82363D^2 - 40.83982D$
OI	$W = \frac{(53.24629+7.91561D^2-37.34973D) + (0.30832D^{3.28170})}{2}$
OT	$W = 402.37775 + 13.83454D^2 - 128.58822D$

TABLE 15

Yield per acre of dry weight without bark to a 4-inch dob of trees 5-inches dbh or more (lbs.).

Total age (years)	Site Index 40	50	60	70	80
10	0	0	0	0	0
20	0	2159	4232	9787	22114
30	8786	19985	31253	45141	53271
40	24965	38137	50879	62126	70580
50	36890	50513	67714	78007	90168
60	48891	61982	78348	89202	96150
70	55007	69693	84051	93022	99974
80	61986	80585	88875	100439	103898
90	71092	85925	95911	105117	106097
100	76864	91547	99247	108510	111863

Class	Equation
WO	$W = 1.32023D^{2.56152}$
BO	$W = 67.75124 + 7.65651D^2 - 35.67783D$
OI	$W = \frac{(80.80178+7.31852D^2-41.68462D) + (0.22240D^{3.37432})}{2}$
OT	$W = 336.79891 = 12.04526D^2 - 109.34929D$

TABLE 16
Yield per acre of dry weight of bark to a 4-inch dob of trees 5-inches dbh or more (lbs.).

	Site Index				
Total age (years)	40	50	60	70	80
10	0	0	0	0	0
20	0	368	746	1904	3975
30	1609	3397	5331	7757	9318
40	4061	6371	8661	10538	12048
50	6018	8472	11333	13374	15918
60	8059	10452	13276	15655	17335
70	9019	11745	14413	16852	18191
80	10470	13683	16142	18357	18819
90	11663	15063	17389	19510	20164
100	13083	16252	17977	20499	21300

Note: (Table 14 values) - (Table 15 values).

TABLE 17
Percent of total dry weight per acre which is bark.

	Site Index				
Total age (years)	40	50	60	70	80
10	17.9	17.9	17.5	17.4	17.4
20	16.6	16.3	16.3	16.2	15.9
30	15.5	15.3	15.4	15.3	15.2
40	15.0	14.9	14.9	14.8	14.6
50	14.7	14.5	14.6	14.3	14.2
60	14.3	14.4	14.1	14.1	14.0
70	14.3	14.2	13.9	13.8	13.8
80	14.2	14.0	13.8	13.5	13.4
90	14.0	13.6	13.7	13.5	13.5
100	13.7	13.5	13.6	13.3	13.3

Note: $\left[\frac{\text{(Table 4 values)}}{\text{(Table 2 values)}}\right](100)$

TABLE 18

Percent of yield per acre of dry weight of wood without bark in material 4-inches dob or less.

	Site Index				
Total age (years)	40	50	60	70	80
10	100	100	100	100	100
20	100	93	87	76	58
30	77	60	47	35	30
40	52	39	31	26	25
50	40	31	26	25	25
60	32	27	25	25	26
70	28	25	25	26	27
80	27	25	25	26	27
90	25	25	25	27	29
100	25	25	26	28	29

Note: $$\left[\frac{(\text{Table 3 values}) - (\text{Table 15 values})}{(\text{Table 3 values})}\right](100)$$

TABLE 19

Percent of yield per acre of green weight of wood and bark in material 4-inches dob or less.

Total age (years)	Site Index 40	50	60	70	80
10	100	100	100	100	100
20	100	93	87	75	57
30	77	60	46	35	29
40	52	39	30	26	24
50	40	31	25	24	24
60	31	26	23	23	24
70	27	24	23	24	25
80	25	23	23	24	25
90	23	23	23	24	26
100	23	22	23	25	27

Note: $$\left[\frac{\text{(Table 1 values) - (Table 13 values)}}{\text{(Table 1 values)}}\right](100)$$

TABLE 20

Percent of dry weight of wood and bark in various categories.

	Site Index														
	40			50			60			70			80		
Total age	<5" dbh	≥5" dbh		<5" dbh	≥5" dbh		<5" dbh	≥5" dbh		<5" dbh	≥5" dbh		<5" dbh	≥5" dbh	
(years)		>4" dob	<4" dob		>4" dob	<4" dob		>4" dob	<4" dob		>4" dob	<4" dob		>4" dob	<4" dob
10	100	0	0	100	0	0	100	0	0	100	0	0	100	0	0
20	100	0	0	91	7	2	84	12	4	69	24	7	46	42	12
30	71	23	6	49	40	11	32	53	15	18	64	18	10	70	20
40	39	48	13	22	61	17	12	69	19	6	73	21	3	75	22
50	24	60	16	12	69	19	5	74	21	3	75	22	2	75	23
60	14	68	18	7	73	20	2	76	22	1	76	23	1	75	24
70	9	72	19	4	75	21	2	76	22	1	75	24	1	74	25
80	6	74	20	2	76	22	1	76	23	1	75	24	1	74	25
90	5	75	20	2	76	22	1	76	23	0	75	25	1	73	26
100	3	76	21	1	77	22	0	76	24	0	75	25	0	73	27

Note:

$$\begin{array}{l}\geqslant 5'' \text{ dbh} \\ < 4'' \text{ dob}\end{array} = \left[\frac{(\text{Table 6 values}) - (\text{Table 14 values})}{(\text{Table 2 values})}\right](100)$$

$$\begin{array}{l}\geqslant 5'' \text{ dbh} \\ > 4'' \text{ dob}\end{array} = \left[\frac{(\text{Table 14 values})}{(\text{Table 2 values})}\right](100)$$

$$< 5'' \text{ dbh} = 100 - (\text{sum of above percents})$$

Branch tables were not used as equations on which they were based were relatively weak.

TABLE 21

Percent of maximum mean per-acre annual growth of wood without bark at successive ages.

Total age (years)	Site Index				
	40	50	60	70	80
10	93	75	82	75	72
20	90	93	86	86	100
30	99	100	100	100	97
40	100	94	94	91	90
50	95	88	94	89	92
60	93	85	89	85	83
70	85	80	82	77	75
80	82	80	76	73	68
90	82	76	73	69	63
100	80	73	69	64	60

Note: Obtained by determining maximum per-acre per-year yield for a given site index in Table 3 and dividing that value into each value in the column (x100).

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